The effects of the type of anesthesia on outcomes of lower extremity infrainguinal bypass

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Objective: **Three main types of anesthesia are used for infrainguinal bypass: general endotracheal anesthesia (GETA), spinal anesthesia (SA), and epidural anesthesia (EA). We analyzed a large clinical database to determine whether the type of anesthesia had any effect on clinical outcomes in lower extremity bypass.**

Methods: **This study is an analysis of a prospectively collected database by the National Surgical Quality Improvement Program (NSQIP) of the Veterans Affairs Medical Centers. All patients from 1995 to 2003 in the NSQIP database who underwent infrainguinal arterial bypass were identified via Current Procedural Terminology codes. The 30-day morbidity and mortality outcomes for various types of anesthesia were compared by using univariate analysis and multivariate logistic regression to control for confounders.**

Results: **The NSQIP database identified 14,788 patients (GETA, 9757 patients; SA, 2848 patients; EA, 2183 patients) who underwent a lower extremity infrainguinal arterial bypass during the study period. Almost all patients (99%) were men, and the mean age was 65.8 years. The type of anesthesia significantly affected graft failure at 30 days. Compared with SA, the odds of graft failure were higher for GETA (odds ratio, 1.43; 95% confidence interval [CI], 1.16-1.77; *P* = .001). There was no statistically significant difference in 30-day graft failure between EA and SA. Regarding cardiac events, defined as postoperative myocardial infarction or cardiac arrest, patients with normal functional status (activities of daily living independence) and no history of congestive heart failure or stroke did worse with GETA than with SA (odds ratio, 1.8; 95% CI, 1.32-2.48; *P* < .0001). There was no statistically significant difference between EA and SA in the incidence of cardiac events. GETA, when compared with SA and EA, was associated with more cases of postoperative pneumonia (odds ratio: 2.2 [95% CI, 1.1-4.4; *P* = .034]. There was no significant difference between EA and SA with regard to postoperative pneumonia. Compared with SA, GETA was associated with an increased odds of returning to the operating room (odds ratio, 1.40; 95% CI, 1.20-1.64; *P* < .001), as was EA (odds ratio, 1.17; 95% CI, 1.05-1.31; *P* = .005). GETA was associated with a longer surgical length of stay on univariate analysis, but not after controlling for confounders. There was no significant difference in 30-day mortality among the three groups with univariate or multivariate analyses.**

Conclusions: **Although GETA is the most common type of anesthesia used in infrainguinal bypasses, our results suggest that it is not the best strategy, because it is associated with significantly worse morbidity than regional techniques. (J Vasc Surg 2006;44:964-70.)**

The number of individuals affected by peripheral arterial disease of the lower extremity is increasing rapidly as the population in the United States ages.[1] Many of these individuals meet criteria for lower extremity revascularization, and most are high-risk surgical patients. Many factors contribute to the morbidity and mortality of these patients, such as the high incidence of coronary artery disease. A total of 5% to 15% of patients undergoing peripheral vascular surgery have perioperative myocardial infarction.[2] The results of prior studies that attempted to investigate the effect of the type of anesthesia on outcomes of infrainguinal bypasses have varied.[3,4]

General endotracheal anesthesia (GETA), epidural anesthesia (EA), and spinal anesthesia (SA) are the three methods commonly used during lower extremity arterial bypass surgery. All of these types of anesthesia have been proven safe in vascular surgery procedures.[5] However, the literature has not been very clear on the issue of which type of anesthesia a patient receives for infrainguinal bypass is the safest in terms of postoperative complications, including early graft failure. Therefore, the type of anesthesia used is usually at the discretion of the anesthesiologist and the surgeon, and it is usually based on their experience and comfort in the administration of one type of anesthesia over another.

To examine and compare the safety of the three common types of anesthesia used, we queried the database of the Veterans Affairs (VA) National Surgical Quality Improvement Program (NSQIP). This database is risk-adjusted, validated, and peer-controlled. The data are collected in each medical center by using a trained nurse reviewer.

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Table I. Current Procedural Terminology codes for infrainguinal bypass

Code	*Procedure*
35556	Fem-pop with vein
35566	Fem-AT/PT/Per with vein
35571	Pop-AT/PT/Per with vein
35583	Fem-Pop in situ
35585	Fem-AT/PT/Per in situ
35587	Pop-AT/PT/Per in situ
35656	Fem-Pop with prosthetic
35666	Fem-AT/PT/Per with prosthetic
35671	Pop-AT/PT/Per with prosthetic

Fem, Femoral; *Pop*, Popliteal; *AT*, anterior tibial; *PT*, posterior tibial; *Per*, peroneal.

METHODS

Database. The specifics of the VA NSQIP database have been described in detail in prior studies.[6] In brief, 123 VA medical centers in the United States participate in the NSQIP study by prospectively collecting data on surgical patients and following up these patients for 30 days for specific outcomes. All variables in the NSQIP are collected by dedicated staff in a prospective manner, and patients are followed up for 30 days after surgery, thus allowing for effective collection of data on surgical patients in the VA system undergoing surgery under GETA, EA, and SA.

Sample selection. We queried the database, using Current Procedural Terminology codes, for all patients who underwent infrainguinal lower extremity arterial bypass procedures from January 1, 1995, to December 31, 2003. The specific infrainguinal bypass codes pulled from the NSQIP database are listed in Table I. We included all patients with one of these Current Procedural Terminology codes and who underwent GETA, EA, or SA.

Outcome variables. The following 30-day postoperative outcomes were analyzed: graft failure (defined as an occlusion of the new graft necessitating a return to the operating room [OR] or balloon angioplasty); cardiac event (defined as any postoperative cardiac arrest or myocardial infarction); postoperative pneumonia (defined by Centers for Disease Control criteria); related return to the OR (defined as any return to the OR related to the index procedure); and postoperative length of stay (LOS). Death was identified via the Beneficiary Identification and Records Locator System subsystem (BIRLS).

Baseline patient demographic characteristics and comorbid conditions. Patient baseline characteristics included age, sex, and race (black vs white). Clinical characteristics included in the database were history of stroke, congestive heart failure (CHF), chronic obstructive pulmonary disease, diabetes (none or diet controlled vs oral hypoglycemics vs insulin requiring), need for any assistance with activities of daily living (ADL), and American Society of Anesthesiologists classification. We also defined current smoking as smoking cigarettes within 1 year of the operation and current alcohol use as at least 28 alcoholic drinks in the 2 weeks before the operation. Finally, the database included several preoperative laboratory variables on most patients, including serum albumin, hematocrit, white blood cell count, platelet count, prothrombin time, partial thromboplastin time, creatinine, and blood urea nitrogen.

Statistical analysis. All of the baseline characteristics for each individual outcome were screened for inclusion in the multivariate model by using χ^2, analysis of variance, or the Student t test, as appropriate. Because nearly all variables were associated ($P < .25$) with either the choice of anesthesia or the outcome of interest, we entered all variables into the initial model and then removed variables that were neither significant nor confounders. We used hierarchical logistic regression for multivariate modeling, clustering by the region of the country.

We also included the institution's preference for anesthesia into each model. We attempted to use linear regression for postsurgical LOS, but the heteroscedasticity assumption was grossly violated, so we reclassified postsurgical LOS into a binary variable: longest quartile vs all others. Because anesthesia choice was the primary exposure of interest, we checked for interaction between anesthesia type and each variable that was included in the final model. Final models were checked for overall goodness of fit by using the Hosmer-Lemeshow method. All P values were two tailed with a significance level set at .05. Analyses were conducted with Stata 8.0 (Stata Corporation, College Station, Tex).

RESULTS

Using the Current Procedural Terminology codes included in Table I, we identified 14,788 patients who had lower extremity infrainguinal surgical revascularizations during the study period. Baseline demographic characteristics, clinical comorbidities, and laboratory data are summarized in Table II. Because of the large size of the database, the differences in numerous characteristics are statistically significant, although they may not be clinically pertinent because the actual differences are rather small. For example, although SA patients had (significantly) the highest albumin level, the difference in albumin levels between GETA and SA patients was 0.08 mg/dL, a difference that is not clinically pertinent. The number of specific procedures and the type of anesthesia administered are listed in Table III. The most common procedures were infrainguinal bypasses performed with autogenous vein, and femoral-popliteal bypasses were the most common bypasses. Although most patients (n = 9757; 66%) had GETA, followed by SA (n = 2848; 19%) and EA (n = 2183; 15%), the proportion of procedures in each anesthetic group was similar; therefore, the difference among the 3 groups in morbidity is not due to the types of procedures performed in each group.

Graft failure. There were a total of 723 (4.9%) graft failures in this cohort. The type of anesthesia significantly affected graft failure at 30 days, even after controlling for confounders in a multivariate model. Compared with SA, the odds of graft failure were 43% higher for GETA (odds ratio, 1.43; 95% confidence interval [CI], 1.16-1.77; P = .001) and trended toward being worse with EA, but this did not reach statistical significance (Table IV).

Table II. Demographic data

Variable	*GETA*	*SA*	*EA*
No. patients	9757	2848	2183
Age (y)*	65.5 (9.9)	66.2 (9.3)†	67 (9.1)†
Male sex (%)	98.9	99.6‡	99.0
Black (%)	15.7	23.4§	18.9§
CHF (%)	4.5	4.7	5.4
COPD (%)	18.0	17.3	21‡
Diet-controlled or no diabetes (%)	57.3	52.4‡	53.4‖
Diabetes with oral hypoglycemic agent (%)	19	20.4‡	20.8‖
Diabetes with insulin (%)	23.7	27.2§	25.8‡
Stroke, resolved deficit (%)	6.2	6.8	7.9‡
Stroke, with deficit (%)	10.1	9.6	10.2
Tobacco use (%)	53.5	50‡	51.4
Alcohol use (%)	12	9.8‡	12.1
Requires ADL assistance (%)	17.1	16.9	18.2
Albumin (mg/dL)*	3.59 (0.64)	3.67 (0.60)†	3.61 (0.61)
Creatinine (mg/dL)*	1.36 (1.2)	1.37 (1.2)	1.37 (1.2)
Blood urea nitrogen (mg/dL)*	19.2 (11)	19.5 (11)	19.9 (12)¶
Hematocrit (%)*	37.8 (6.2)	38.1 (6.0)	38.5 (6.0)†
White blood cell count (1000/mm^3)*	8.8 (4.0)	8.6 (2.8)#	8.7 (3.0)
Platelet count (1000/mm^3)*	264 (107)	269 (108)	266 (105)

GETA, General endotracheal anesthesia; *SA,* spinal anesthesia; *GA,* general anesthesia; *CHF,* congestive heart failure; *COPD,* chronic obstructive pulmonary disease; *ADL,* activities of daily living.
All comparisons were made against GETA as the reference.
*Mean (SD).
†$P < .001$, analysis of variance.
‡$P < .01$, χ^2 test.
§$P < .001$, χ^2 test.
‖$P < .05$, χ^2 test.
¶$P < .05$, analysis of variance.
#$P < .01$, analysis of variance.

Table III. Type of procedure performed

Type of procedure	*GETA*	*EA*	*SA*	*Total*
Fem-pop with vein	2724 (28%)	533 (24%)	753 (26%)	4010 (27%)
Fem-AT/PT/Per with vein	2358 (24%)	360 (16%)	626 (22%)	3344 (23%)
Pop-AT/PT/Per with vein	584 (6%)	103 (5%)	161 (6%)	848 (6%)
Fem-Pop in situ	498 (5%)	121 (6%)	176 (6%)	795 (5%)
Fem-At/PT/Per in situ	852 (9%)	176 (8%)	284 (10%)	1312 (8%)
Pop-AT/PT/Per in situ	131 (1%)	22 (1%)	39 (1%)	192 (1%)
Fem-Pop with prosthetic	2052 (21%)	777 (36%)	676 (24%)	3505 (24%)
Fem-AT/PT/Per with prosthetic	488 (5%)	72 (3%)	113 (4%)	673 (5%)
Pop-Tib with prosthetic	70 (1%)	19 (1%)	20 (1%)	109 (1%)
Total	9757 (100%)	2183 (100%)	2848 (100%)	14,788 (100%)

Cardiac complications. Multivariate analysis revealed that in patients without a history of CHF or stroke and who have normal functional status (ADL independence), GETA was associated with significantly more cardiac events than SA (odds ratio, 1.8; 95% CI, 1.3-2.5; $P < .001$). There was no significant difference between EA and SA ($P > .2$) in this group. The other variables that were included in the multivariate model were CHF, stroke, American Society of Anesthesiologists class IV, nonblack race, age, diabetes, creatinine, white blood cell count, and need for ADL assistance (Table IV).

Postoperative pneumonia. Those who received GETA were more likely to be diagnosed with pneumonia within 30 days of the procedure than those who received either SA or EA (2.1% vs 1.0% vs 1.0%, respectively; $P < .001$). This was again confirmed on multivariate analysis, on which GETA had higher odds of developing pneumonia (odds ratio, 2.2; 95% CI, 1.0-4.6; $P = .034$) vs SA. EA did not have statistically higher odds of developing pneumonia vs SA. Other important variables included a history of stroke, chronic obstructive pulmonary disease, or insulin-requiring diabetes mellitus; older age; lower albumin; and a white blood cell count >13 (1000/mm^3) (Table IV).

Related return to the OR. In comparison to SA, GETA was associated with a 40% increase in the odds of a return to the OR (odds ratio, 1.40; 95% CI, 1.20-1.64; $P < .001$), and EA was associated with a 17% increase (odds ratio, 1.17; 95% CI, 1.05-1.31; $P = .005$; Table IV). This

Table IV. Outcome variables and type of anesthesia

	GETA			EA		
Outcome variable	*Odds ratio*	*95% CI*	P *value*	*Odds ratio*	*95% CI*	P *value*
Graft failure	1.43	1.16-1.77	.001	1.39	0.97-2.0	.075
Cardiac events	1.8	1.32-2.48	<.0001	1.37	0.80-2.35	.257
Postoperative pneumonia	2.2	1.10-4.40	.034	1.04	0.64-1.72	.085
Related return to the operating room	1.40	1.20-1.64	<.001	1.17	1.05-1.31	<.005

GETA, General endotracheal anesthesia; *EA,* epidural anesthesia; *CI,* confidence interval.
Spinal anesthesia was used as the reference in the multivariate model.

was the only outcome in which SA was significantly better than EA.

Surgical LOS. The average LOS for patients undergoing SA was 10.2 days; for EA, it was 9.4 days; and for GETA, it was 11.2 days. After controlling for 15 other variables, multivariate analysis indicated that there was no significant difference in the postoperative LOS between SA and GETA (odds ratio, 1.24; 95% CI, 0.99-1.56; *P* = .065) or between SA and EA (odds ratio, 1.04; 95% CI, 0.84-1.28; *P* = .72).

Death. There were 230 deaths in the group studied. There was no significant difference in 30-day mortality rates between the 3 types of anesthesia on univariate analysis or after controlling for confounders (history of stroke, CHF, chronic obstructive pulmonary disease, American Society of Anesthesiologists class, diabetes, ADL assistance, and type of surgery; GETA vs SA, *P* = .34; GETA vs EA, *P* = .14; SA vs EA, *P* = .13 on multivariate analysis).

DISCUSSION

In this large patient population undergoing infrainguinal lower extremity arterial bypass, GETA was the most commonly used type of anesthetic technique in general and in every bypass configuration in particular. However, GETA was associated with worse results in most of the outcome variables studied. Our results reveal that compared with GETA, SA was associated with superior 30-day graft patency, fewer cardiac events in patients without CHF but with normal functional status, less postoperative pneumonia, and decreased odds of returning to the OR. In contrast, SA was significantly better than EA only in the incidence of return to the OR.

Previous studies have also noted that regional anesthesia was associated with better graft patency than GETA.[7,8] In an attempt to find an explanation for this finding, Perler et al[9] noted that GETA and increased plasminogen activator inhibitor 1 levels were associated with higher rates of graft occlusion, and Rosenfeld et al[10] found increased postoperative levels of plasminogen activator inhibitor 1 in the general anesthetic group, with no significant increase in plasminogen activator inhibitor 1 levels in the epidural-only group. Further studies by Parker noted that the better graft patency associated with regional anesthesia may occur because of the modulation of stress.[11] In addition, EA has been shown to improve postoperative lower extremity blood flow by increasing arterial inflow and venous emptying.[12]

However, not all investigators have been able to confirm the detrimental effect of GETA on graft failure. In a randomized prospective study that was initially intended to detect cardiac morbidity, Pierce et al[13] noted that the type of anesthesia given did not significantly affect the 30-day occlusion rate of vascular grafts. Cook et al[14] also found no difference in lower extremity amputation rates in a prospective study comparing SA and general anesthesia. However, both of these studies were single-center studies with a limited number of patients.

Regarding cardiac complications, in contrast to the current study, in which GETA was found to be worse in patients with no history of CHF and with a normal functional status, the literature has not been uniform in this regard.[15-18] Although some studies have shown a decrease in myocardial events in patients undergoing major vascular surgery who underwent EA,[19] most studies have found no difference in cardiac events in patients undergoing regional or general anesthesia.[20,21]

Although there was a higher incidence of the above-mentioned complications with GETA, this did not translate into a statistically longer LOS or an increase in 30-day mortality. Regarding the LOS, the data analyzed were collected over a very long time period in which the LOS in VA hospitals sustained a gradual decline. This may have affected the results that have been averaged over the entire time period of the study. The 30-day mortality was not significantly different among the groups, and this may reflect the overall low mortality in the cohort. Regarding EA and SA, there were no statistically significant differences between these two types of anesthesia except in related returns to the OR, for which there was a 20% higher chance of return with EA. The clinical significance of this observation is not clear, and a definite conclusion regarding the superiority of SA vs EA cannot be made on the basis of this one outcome.

This study has the limitations that are inherent with retrospective reviews of large databases. For example, the specific agents used for anesthesia and analgesia in these patients are not available. It is also difficult to ascertain the specific nuances of each particular case. Redo procedures and those that required spliced vein or arm vein could not be elucidated because the database was queried via Current Procedural Terminology codes, and there were no separate codes for these procedures; add-on codes that describe these configurations became available only in the last 5 years. Additionally, operative time could not be calculated because this was not included in the dataset, and indications for the procedures cannot be identified in this database. Thus, even though the distribution of infrainguinal bypass procedure types between the anesthesia groups was equivalent, we cannot exclude the potential that GETA was used for infrainguinal bypass procedures that were more complex, and this could have influenced our results. Regardless, the reporting standards of NSQIP are strict, and the data are extremely well collected. Furthermore, the significance of our study includes its size, prospective collection of the data, and data adjustment. In addition, the procedures were performed in many centers, and this makes the results of this current study more applicable to the general population than single-center results.

As with any retrospective review of prospectively collected data, one always believes that a randomized prospective study is needed to elucidate further a true difference in outcomes. We used the data for graft failure collected from our study to estimate the sample size needed for a randomized control trial ($\alpha = .05$ and $\beta = .20$) and noted that more than 20,000 patients divided equally among the 3 anesthesia groups would be required to show statistical significance. Even in a multicenter trial, it is rather difficult to obtain such a large cohort of patients, especially now in the age of endovascular therapy. This highlights the significance of the current study.

In conclusion, although GETA continues to be used more often than any other type of anesthesia for lower extremity infrainguinal bypasses, our data suggest that GETA is associated with a significantly worse 30-day outcome when compared with regional anesthesia. However, this worse outcome was limited to complications and not mortality.

AUTHOR CONTRIBUTIONS

Conception and design: NS, ANS, KD, RFN, JW, SA, GA, CA, EA
Analysis and interpretation: NS, ANS, KD, RFN, JW, SA, GA, CA, EA
Data collection: NS, KD, SK, WH
Writing the article: NS, ANS, KD, RFN, JW, SA, GA, CA, EA
Critical revision of the article: NS, ANS, KD, RFN, JW, SA, GA, CA, EA
Final approval of the article: NS, ANS, KD, RFN
Statistical analysis: NS, ANS, KD
Overall responsibility: NS

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DISCUSSION

Dr Bruce Perler (Baltimore, Md). Working in a teaching hospital, it pains me to recall the dozens of hours I've wasted pacing the halls waiting for an anesthesia resident to place a spinal or epidural anesthesia. In fact, for years, I pontificated the adage that "general anesthesia means never having to say you're sorry."

I must say, in all candor, I'm now a born-again believer in regional anesthesia. And my awakening came as a result of a randomized prospective trial we did at Hopkins in which we showed that the rate of perioperative graft thrombosis was significantly lower among patients who had their surgery under regional anesthesia.

In the largest series, looking at this issue reported to date, Dr Singh and his colleagues, looking at nearly 15,000 cases, have confirmed our results. Specifically, the rate of 30-day graft failure was 43% higher among patients undergoing general as opposed to spinal anesthesia.

These results really should not be surprising, since we know that regional anesthesia has several physiologic effects which might promote graft flow and enhance very early graft patency. Regional anesthesia produces a transient sympathetic blockade resulting in increased venous arterial flow, venous capacitance, and venous emptying. In addition, regional anesthesia modulates the surgical stress response, which is typically characterized by a rise in catecholamines, aldosterone, angiotensin, renin, and cortisol levels. So while the surgeon's blood pressure and heart rate may increase while waiting for the anesthetic, the patient clearly benefits from a reduced level of circulating, vasoconstricting agents further promoting arterial flow. The surgical stress is also characterized by a transient hypercoagulability state, which is attenuated by regional anesthesia.

I have three questions for the authors.

While your data clearly demonstrate significant and superior early patency for spinal as opposed to general anesthesia, you also found a trend bordering on statistical significance for a higher early graft thrombosis rate among patients undergoing epidural anesthesia. Since the beneficial physiologic effects of epidural and spinal anesthesia are similar, this observation seems counterintuitive. How do you explain the seemingly inferior results with epidural compared to spinal anesthesia?

Second, you observed that among patients with normal functional status and no history of congestive failure, spinal anesthesia was associated with a significantly reduced incidence of cardiac complications. I would assume that the cardioprotective effects of regional anesthesia would be most pronounced and clinically most beneficial among patients with significant cardiac disease. Why didn't you include patients with significant cardiac histories, who probably reflect a major proportion of our practices, in the analysis?

And finally, in light of the lower incidence of graft, cardiac, and pulmonary complications associated with regional anesthesia, I was surprised to see that there was no demonstrated benefit in terms of length of stay. Why was this reduced incidence of complications not reflected in a significantly reduced length of stay?

I think this is a very important paper. I congratulate Dr Singh on an excellent presentation and thank the Society for the privilege of the floor.

Dr Singh. Thank you, Dr Perler. You're obviously one of the pioneers in this field looking at the effects of anesthesia on lower extremity bypass.

Regarding the first question, why do I think epidural anesthesia is associated with worse outcomes than spinal anesthesia? In your work, you describe the beneficial effects of regional vs general anesthesia, and I do not think based upon the past literature and now there should be much difference between spinal and epidural. In essence, there was only one category that was statistically significant, and that was takebacks to the operating room, where epidural anesthesia was worse than spinal anesthesia. The odds ratio was 1.07.

The other area where it approached, but was not statistically significant, was in graft failure. But to answer your question, it's hard to discern, based on our database, why that would be—why there would be a trend towards better outcomes with spinal anesthesia. As I showed, sicker patients are undergoing regional anesthesia, mostly spinal anesthesia, and significantly more patients are undergoing femoral-to-tibial bypass. Based on our database, I can't answer why I think that there's a trend towards better outcomes with spinal anesthesia.

Regarding No. 2, the functional status and the effects on cardiac outcomes, normal functional status and no history of CHF were associated with better outcomes in multivariate analysis. Patients with more comorbidities were undergoing regional anesthesia and, for most outcomes, did better.

Regarding length of stay, these are VA patients in the VA system, and generally their length of stay is longer after lower extremity bypass. It may reflect different cost constraints than other hospitals have or possibly lack of ancillary rehabilitative facilities available to hospitals in more rural locations.

Dr Keith D. Calligaro (Philadelphia, Pa). My question for you is if you analyzed the duration of time of the surgery for the different groups. And the reason I ask that is, although I agree with your findings, there are problems with such a large retrospective study. If a surgeon is doing a fem-tib bypass on a patient who will need splicing of 2 or 3 segments of vein and maybe arm vein segments. Those patients are more likely going to undergo general anesthesia, with a much longer duration of surgery, compared with a patient who is getting a fem-pop prosthetic graft, which you can do under spinal. So did you look at the time of surgery?

Dr Singh. There is a time factor that is provided by NSQIP; however, it was not consistently collected for each patient in our dataset. Therefore, we did not analyze the time.

I agree, you have to know your limitations with timing. Obviously, if you are using upper extremity vein, general anesthesia and a longer duration of anesthesia will be needed. However, in our series, roughly the same proportions of femoral to tibial artery bypasses were under spinal (36%) as were done under general (38%), with better outcomes in the spinal group. This reflects the surgeon likely understanding the time constraints of spinal.

Dr Ellen Dillavou (Pittsburgh, Pa). My question is very closely related to Dr Calligaro's, in that do you think it's possible that the differences you saw between spinal and epidural anesthesia were related to patient selection rather than anesthetic alone? Do you have continuous spinal? What we have with spinal anesthesia is probably a 3- to 4-hour window maximum. And so are you then selecting for better outcome patients with shorter surgeries and that's the differences you're seeing between the groups?

Dr Singh. Our database does discern patients based on the type of anesthesia. It doesn't say whether it's continuous spinal or not.

Dr Dillavou. Did you look at the type of procedure in relation to the anesthetic?

Dr Singh. Looking at the type of anesthetic, 54% of the patients in the general anesthesia group underwent a femoral-to-popliteal bypass.

In the spinal anesthetic group, 56% of the patients underwent a femoral-to-popliteal artery bypass. In the general anesthesia group, 38% underwent a femoral to tibial artery bypass, and in the spinal group, 36%. So we had very similar proportions of patients in each group.

Obviously, like Dr Calligaro said, you have to be selective in the type of operation. If you're splicing vein and you're doing other things, then spinal anesthetic may not be the best choice of anesthesia in that situation.

Dr Theodore S. Pabst III (Plattsburgh, NY). I very much enjoyed your presentation. Two questions: One, the typical problem that I encounter with my anesthesiologists is that they are somewhat concerned with spinal complications (bleeds). Did you have anything in your database that said anything about that?

And second, you noticed an increased risk of cardiac complications, pulmonary complications, and returns to the OR, but that didn't translate into a greater 30-day mortality rate. Can you explain the difference in that?

Dr Singh. Regarding the trends and not having an increase in the death rate, it's hard to explain that. We have 30-day outcomes. We use the beneficiary identification records locater system at the VA to do that. And you can get very good data collection from that, and you can take it out to a longer period of time. But we looked at specific 30-day outcomes. And the immediate death rate was not significantly different between the three groups.

With regard to spinal complications, we have complications overall, but it's not limited to spinal complications. We didn't look at specific outcomes in regard to anesthesia as far as spinal misadventures.